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Using an economic evaluation approach to support specialist nursing services for people with Parkinson's in a regional community

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Abstract

Aim: This study aims to provide economic evidence of the cost-effectiveness of employing specialist Parkinson's nurses in a regional community in Australia.

Study design: This retrospective study utilized hospital service usage data to compare outcomes for people with Parkinson's disease before and after the employment of a specialist Parkinson's nurse in a regional community.

Methods: A representative sample was drawn from the target population of people with a diagnosis of Parkinson's admitted to a regional hospital over a 4-year period (2013–2014 and 2016–2017). A multiple regression approach and cost–benefit analysis were used to examine hospital costs related to length of stay based on hospital records. All costs were attributed to resource allocation according to service category and the national funding system. Quantitative data were analysed using Strata Analytics.

Results: Statistical findings demonstrated a reduction in hospital length of stay ranging from 0.37 (AUD$1924) to 0.755 day (AUD$3926) after the establishment of the specialist Parkinson's nurse. The cost–benefit analysis showed a net dollar benefit, or savings in hospital costs, of up to $8600.00 per person over a 3-year period, as a result of the specialist Parkinson's nurse intervention.

Conclusion: The statistical results show significant cost benefits associated with reduced length of hospital stay following introduction of the specialist Parkinson's nurse. These findings support advocacy for sustainable specialist Parkinson's nurse positions and have the potential to inform and influence policy and systemic changes within the health care system.

Impact: The benefits of embedding specialist nursing services for people with Parkinson's disease in primary health settings include the direct impact on the potential to avoid hospital admissions due to worsening symptoms, improving quality of life for the person with Parkinson's and slowing the trajectory of the disease. Additional benefits are increased access to specialist services and reduced family caregiver burden.

KEYWORDS
cost-effectiveness, nurses, Parkinson's, regional, specialist

1 | INTRODUCTION

Parkinson's disease (Parkinson's) is a neurodegenerative, complex and disabling condition, affecting an estimated 6.3 million people worldwide (Strupp et al., 2017). Over the past generation, the global burden of Parkinson's has more than doubled as a result of increasing numbers of older people, with potential contributions from longer disease duration and environmental factors (Ayton et al., 2019). Demographic and potentially other factors are poised to increase the future burden of Parkinson's substantially (Dorsey et al., 2018; Strupp et al., 2017). In Australia, there are 212,000 people with Parkinson's, and the prevalence of this condition is exceeded only by dementia (Ayton et al., 2019).

The prevalence of Parkinson's increases as the population ages. Eighty per cent of those who have been diagnosed with Parkinson's are over 65 years of age. Overall, Parkinson's affects 4%–5% of the population (Strupp et al., 2017). Access to specialist medical and nursing services becomes increasingly important as the disease progresses and symptoms increase, and attention to improving access to best practice standards is particularly needed in regional, rural and remote areas (Coady et al., 2019; Eggers et al., 2018; Hellqvist et al., 2020).

1.1 | Background

Recent reports have established clear evidence of increasing prevalence of Parkinson's as people age; around 80% of people living with the disease are 65 years and over, and the remaining 20% are of working age (Deloitte Access Economics, 2011, 2015; Parkinson's Australia, 2014). For younger people diagnosed with the disease, the capacity to work and live independently is lost early in the disease trajectory, with each person becoming increasingly dependent over time, placing a very high burden on the person with the disease, on caregivers and families and on society (Mudiyanselage et al., 2017; Pugh et al., 2019). In Australia, an estimated 89% of people with Parkinson's live most of their years at home, with the remaining 11% living in residential facilities (Mudiyanselage et al., 2017).

In Australia, health system costs associated with Parkinson's are the largest component of the financial costs of this condition. Of the total health system costs, aged care costs and hospital inpatient and outpatient costs make up more than 71% of the combined total (Deloitte Access Economics, 2015). While the median number of years lived with Parkinson's is 12.4 years, many people live with the disease for well over 20 years. The average annual financial cost per person living with Parkinson's in 2014 was around $15,400, an increase of 61% since 2005 (Deloitte Access Economics, 2015). Health expenditure per person with Parkinson's per year is greater than for many other diseases, including prostate cancer and breast cancer. This is in part attributed to the increased need for admission to residential aged care as the person's condition deteriorates (Deloitte Access Economics, 2015).

For someone living with Parkinson's for 12 years, the average lifetime financial cost is around $161,300, which is on par with the average lifetime financial cost of cancer ($145,000; Deloitte Access Economics, 2015). A prospective cohort study undertaken in Melbourne sought 'to estimate the annual cost of Parkinson's from household, health system and societal perspectives' (Mudiyanselage et al., 2017, p. 1). The costs were significantly greater than those reported by Deloitte Access Economics (2011, 2015). These researchers likewise noted that 69% of the health care system costs were related to hospitalization with these costs markedly increased for those with more severe Parkinson's (Mudiyanselage et al., 2017, pp. 1 and 5).

The integrated health care system in the United Kingdom in combination with collaboration between the National Health Service, Parkinson's UK and the Parkinson's Disease Nurse Specialists Association enabled the development of a strong policy framework and a national scope of practice for specialist Parkinson's nurses (UK Parkinson's Excellence Network, 2016). In contrast to the United Kingdom, the complexities created by the two-tiered Australian health system has contributed to an absence of well-developed policies and a coherent approach to the delivery of integrated specialist nursing care for people living with Parkinson's. This is particularly noticeable in rural and regional Australia. There is some evidence that nurse-led clinics in Australia can be cost effective and that specialist Parkinson's nurses contribute to an improved health-related quality of life. However, stronger evaluation platforms and frameworks are required to substantiate the limited evidence (Jones et al., 2016; Randall et al., 2017).

Parkinson's NSW (PNSW) is a not-for-profit organization focused on enabling people living with Parkinson's to live well with this disease. In order to support this focus and advocate effectively for the implementation of specialist Parkinson's nurse positions in regional New South Wales. PNSW funded an integrative literature review to examine evidence for best practice models of nurse-led specialist care for people living with Parkinson's (Bramble et al., 2018) and an evaluation of the impact and effectiveness of two separate specialist Parkinson's nurse positions in NSW (Rossiter et al., 2019). Nursing researchers from Charles Sturt University partnered with PNSW and the Mid North Coast Local Health District (MNCLHD) to undertake the research. The final component of the research was designed to examine the cost-effectiveness of one of the specialist Parkinson's nurse positions (Bramble et al., 2019).

Data from a nurse-led clinical practice improvement project conducted in a hospital setting in the MNCLHD between 2015 and 2018 provided the catalyst for this final component (Carroll et al., 2020). The data collected had revealed positive impacts, including a reduction in length of stay (LOS), improved patient safety and increased patient satisfaction with medication management as a result of this clinical practice improvement project (Bramble et al., 2019; Carroll et al., 2020).

2 | THE STUDY

2.1 | Aims

This study aims to examine the cost-effectiveness of employing specialist Parkinson's nurses in a regional community in Australia.

2.2 | Study design

This study forms part of the larger project that sought to examine evidence for the effectiveness of specialist Parkinson's nurses in regional areas in Australia (Bramble et al., 2018; Rossiter et al., 2019). While challenging to conduct, economic evaluations in health care are undertaken to inform resource allocation decisions or to evaluate the consequences of a health intervention (Husereau et al., 2013). Prior to commencing this project, extensive consultation with relevant experts from NSW Health and the project advisory group supported the development of a focused program logic identifying the processes required to access the relevant data and formalize the study design (Bramble et al., 2019).

The study utilized hospital service usage data to compare outcomes for people with Parkinson's before and after the intervention, that is, employment of a specialist Parkinson's nurse in a regional community. The preintervention period was 2013–2014, while the postintervention period was 2016–2017. Initial establishment of the position took place in 2015. The study design (see Figure 1) consists of two key components: (1) a retrospective comparison of hospital LOS and readmissions between the 2013–2014 data and the 2016–2017 data and (2) a cost–benefit analysis of services provided by the specialist Parkinson's nurse (2016–2017). These two components were incorporated in the design to identify the impact of the specialist Parkinson's nurse and to compare LOS between the two time periods.

2.3 | Study location

The intervention was conducted in the MNCLHD in NSW, Australia. This region is rated as 'Outer Regional' on the accessibility/remoteness index (ARIA), which measures the remoteness of a point based on physical road distance to the nearest service facility in an urban centre (Australian Bureau of Statistics (ABS), 2018). For people living with Parkinson's in this region, the travel required to reach many specialist services, such as movement disorder neurology services, is considerable and adversely impacts on accessibility. The specialist Parkinson's nurse position is a community-based position situated at the Mid North Coast Brain Injury Rehabilitation Service in Coffs Harbour. The Coffs Harbour Base Hospital is the major referral hospital for the Coffs Harbour and Mid North Coast regions and is the primary acute care service to which people with Parkinson's are admitted (Figure 2).

2.4 | Target population and sample

The target population was identified as all patients with Parkinson's admitted to the Coffs Harbour Base Hospital between the periods 1 January 2013 and 31 December 2014 and between 1 January 2016 and 31 December 2017. The total client base of people with Parkinson's across the MNCLHD was estimated to be approximately 500. A purposive sample was drawn from the population of Parkinson's patients admitted to the Coffs Harbour Base Hospital, the reason for admission identified as primarily due to Parkinson's, or due to a secondary cause.

2.5 | Data collection

2.5.1 | Patient data

The hospital costs evaluated in this study are retrospective and based on data available on patient LOS and readmission. Preliminary data were provided by the Health Information Exchange (HIE) for the Local Health District, the database used as the reference tool to extract the relevant

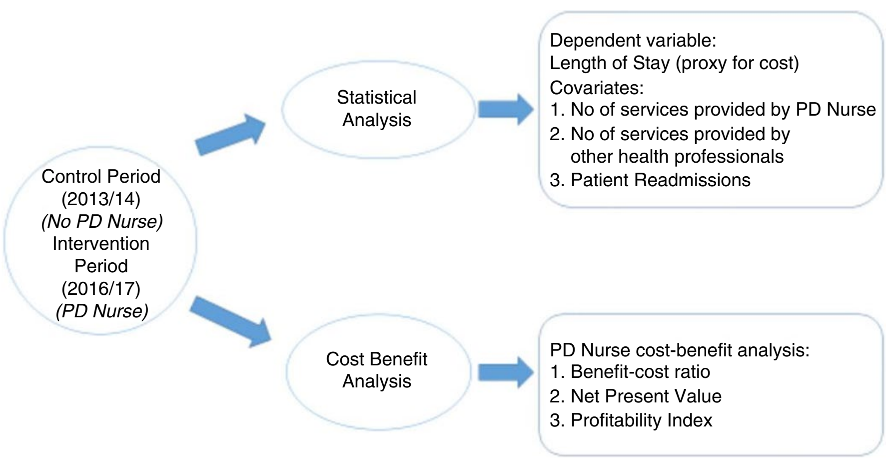

FIGURE 1 Study design

FIGURE 2 Location of study site. Source: Australian Bureau of Statistics (ABS), (2018)

International Classification of Diseases (ICD) Codes and analysis of costs uses cost–benefit analysis (Harris & Fry, 2017; Harrison, 2010).

2.6 | Ethical considerations

Ethics approval for the project was gained from the North Coast NSW Human Research Ethics Committee (No. 218/ETH00278) in 2018 and later approved by Charles Sturt University's Human Research Ethics Committee.

2.7 | Data analysis

The retrospective analysis compared Parkinson's patient outcomes before and after the employment of the specialist Parkinson's nurse in the MNCLHD. A representative sample was drawn from the target population of people with a diagnosis of Parkinson's identified in hospital medical records over a 4-year period (2013–2014 and 2016–2017). A multiple regression approach and cost–benefit analysis were used to examine hospital costs related to LOS. Quantitative data were analysed using Strata Analytics. Costs were attributed to resource allocation according to service category, as described below. All costs were reported in 2019 Australian dollars.

Hospitalization data, including number of admissions, readmissions and total LOS over a 12-month period were obtained from clinical documentation in the patient health record abstracted via the Clinical Coding process post-patient discharge from the Coffs Harbour Base Hospital. All inpatient episodes were coded using the ICD 10–AM classification for all care types that is, as an acute patient or a subacute and nonacute admitted patient (SNAP; Independent Hospital Price Authority, 2019). The mean cost of a hospital admission per day was calculated using the national average cost per weighted separation from the Australian Independent Hospital Pricing Authority (IHPA; $5200 NSW) as sourced from the National Hospital Cost Data Collection Round 22 (Independent Hospital Price Authority, 2018).

This cost is derived from the Australian National Efficiency Price (NEP), used to calculate Commonwealth payments for public hospital services, and underpins the National Activity-Based Funding system (Calder et al., 2019; Independent Hospital Price Authority, 2019).

2.8 | Validity, reliability and rigour

Initial consultations with the project advisory group were undertaken to ensure both the research design and processes to access relevant data were valid and rigorous (Bramble et al., 2019). Further consultation with industry partners was sought during the data collection process. These industry partners undertook a detailed review of the data analysis and interpretation of the findings.

A stratified sample from the total population was identified to ensure relationships between variables conform to statistical validity (Bloem et al., 2017; Faul et al., 2007). The G*Power 3 power analysis program was used to estimate the required size of the sample, which resulted in a sample size of 32 patients per year preintervention and 32 patients per year postintervention. This was to ensure a medium effect size and an alpha level of .05 in the statistical analysis (Faul et al., 2007).

This research was reported according to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) for the reporting of health economic evaluations (Husereau et al., 2013).

2.8.1 | Estimation using regression analysis

To examine the impact of the specialist Parkinson's nurse services on the LOS in hospital for Parkinson's patients, a multiple regression approach was used. This approach enabled the investigators to examine any statistical and economic significance that may exist between the LOS and the selected independent variables: (i) Number of services provided by the specialist Parkinson's nurse, (ii) number of services provided by other health professionals (Allied Health services) and (iii) patient readmission.

To ensure robustness of test results, three models (M1, M2 and M3) were chosen for the analysis as follows:

- M1 is the basic model that attempts to predict the LOS in hospital given the number of services provided by the specialist Parkinson's nurse (PDN) and other health professionals (OPN).
- M2 includes the impact of patient readmission on LOS in addition to services provided by the specialist Parkinson's nurse (PDN) and other health professionals (OPN).
- M3 extends M2 further by including an additional dummy variable (YRD) that attempts to isolate the post specialist Parkinson's nurse intervention period from the pre intervention period using all observations from the sample periods 2013, 2014, 2016 and 2017.

$$LOS = \alpha_0 + \alpha_1 PDN + \alpha_2 OPN + \varepsilon_1, \quad \text{(M1)}$$

$$LOS = \alpha_0 + \alpha_1 PDN + \alpha_2 OPN + \alpha_3 RAD + \varepsilon_2, \quad \text{(M2)}$$

$$LOS = \alpha_0 + \alpha_1 PDN + \alpha_2 OPN + \alpha_3 RAD + \alpha_4 YRD + \varepsilon_3, \quad \text{(M3)}$$

where α_0 = intercept term; LOS = average LOS (days) of the Parkinson's patient over the sample period; PDN = number of services performed by the specialist Parkinson's nurse; OPN = number of services performed by other health professionals (Allied Health) (*please note that analysis of other health professionals is not included in this study*); RAD = dummy variable for readmission; RAD = 1 if readmitted once or more, otherwise = 0; YRD = dummy variable for intervention period. YRD = 1 for the specialist Parkinson's nurse intervention period (2016–2017) and 0 for nonintervention period (2013–2014).

The RAD dummy variable examines the impact of patient readmission on LOS in comparison with nonreadmission. The intervention period effect on LOS versus nonintervention period is captured by the dummy variable YRD.

TABLE 1 Demographic characteristics

Characteristics	2013–2014, N = 64 (50%)	2016–2017, N = 64 (50%)
Gender		
Male	47 (73.4%)	36 (56.2%)
Female	17 (26.6%)	28 (43.8%)
Age on admission		
45–49	1 (1.6%)	0 (0%)
50–54	1 (1.6%)	0 (0%)
55–59	2 (3.1%)	1 (1.6%)
60–64	4 (6.3%)	2 (3.1%)
64–69	0 (0%)	3 (4.7%)
70–74	11 (17.1%)	4 (6.3%)
75–79	12 (18.8%)	11 (17.1%)
80–84	13 (20.3%)	19 (29.7%)
85–89	14 (21.9%)	16 (25.0%)
90–94	5 (7.7%)	8 (12.5%)
95–99	1 (1.6%)	0 (0%)
Relationship status		
Married/de facto	38 (59.3%)	31 (48.4%)
Widowed	17 (26.6%)	22 (34.4%)
Divorced/single	9 (14.1%)	11 (17.2%)
Country of birth		
Australia	52 (81.2%)	56 (87.5%)
Country other than Australia	12 (18.8%)	8 (12.5%)
Years since diagnosis		
<5 years	32 (50.0%)	39 (60.9%)
5–9 years	21 (32.8%)	17 (26.6%)
10–19 years	9 (14.1%)	7 (10.9%)
20–35 years	2 (3.1%)	1 (1.6%)
Residence at diagnosis		
Home	54 (84.4%)	50 (78.1%)
Residential care	10 (15.6%)	14 (21.9%)
Residence on admission		
Home	33 (51.6%)	30 (46.9%)
Residential care	31 (48.4%)	34 (53.2%)

3 | RESULTS/FINDINGS

3.1 | Sample characteristics

The sample of 128 participants ranged in age from 45 to 96 years old with 65% being male and 35% female (see Table 1). The largest number from this sample admitted to hospital was those aged between 80 and 94, as follows: 80–84 (25.0%), 85–89 (23.4%), 75–79 (17.9%), 70–74 (11%) and 90–94 (10.2%). Those aged 65 and above constituted 89.2% of the total with 10.9% falling within the 45–64 age groups. The majority (54.7%) were married or de facto, with 30.5% widowed and 14.8% divorced of single. Most patients were born in Australia (84.4%) as compared with 15.6% born in another country. The greater percentage had been diagnosed within the last 4 years (55.5%), with 30.4% diagnosed within the last 5 to 9 years, 12.4% diagnosed within the last 10–19 years and 1.6% diagnosed between 20 and 35 years ago. At the time of diagnosis, most patients lived at home (88.3%) with 11.7% living in a residential care facility. At the time of admission to hospital, the percentage living at home had decreased to 64.8% with a parallel increase to 35.2% of the total living in a residential care facility.

3.2 | Descriptive statistics

Descriptive statistics for the chosen variables are shown in Table 2. The full sample includes a total of 128 observations with

TABLE 2 Descriptive statistics

	Mean	Max	Min	*SD*	*N*
2017					
PDN	2.66	13	0	4.02	32
OPN	52.97	229	2	51.21	32
LOS	14.16	53	4	12.48	32
RAN	0.44	4	0	0.80	32
RAD	0.34	1	0	0.48	32
2016					
PDN	1.91	14	0	3.85	32
OPN	10.34	69	0	15.9	32
LOS	7.76	20	1.8	4.14	32
RAN	1.50	6	0	1.67	32
RAD	0.53	1	0	0.51	32
2014					
PDN	0	0	0	0	32
OPN	18.77	88	1	17.38	32
LOS	8.37	21	2	4.91	32
RAN	1.19	8	0	1.75	32
RAD	0.50	1	0	0.51	32
2013					
PDN	0	0	0	0	32
OPN	17.63	89	1	17.8	32
LOS	8.32	49	2	9.13	32
RAN	1.34	4	0	1.15	32
RAD	0.75	1	0	0.44	32
Full sample					
PDN	1.16	14	0	3.01	128
OPN	25.02	229	0	33.77	128
LOS	9.65	53	1.8	8.68	128
RAN	1.12	8	0	1.44	128
RAD	0.53	1	0	0.50	128

Note: Table 2 provides a summary of statistical data collected over the sample period 2013–2014 and 2016–2017. A total of 128 individual PD patient records were collected. The monthly patient records are aggregated to provide estimates for number of services provided by the PD nurse and health services provided by other health professionals (Allied Health). *N* is number of participants.

Abbreviations: LOS, length of stay; OPN, other health professionals; PDN, specialist Parkinson's disease nurse; RAD, dummy variable for readmission; RAN, number of times of readmission.

32 observations for each of the four subsamples. As expected, the number of services provided by the specialist Parkinson's nurse recorded a value of zero for the 2013 and 2014 subsamples because these services were not available prior to 2015.

3.3 | Results of regression analysis

The regression analysis first focuses on the post specialist Parkinson's nurse intervention period (2016–2017). M1 and M2 are estimated for this sample period by aggregating data from the 2016 and 2017 subsamples. The pooled data provide an overall analysis of the effect of the specialist Parkinson's nurse intervention on the LOS. Because the specialist Parkinson's nurse employment hours increased from 5 days per fortnight (in 2016) to 7 days per fortnight (in 2017), an additional analysis was also performed for the 2016 and 2017 subsamples separately in order to check for sensitivity of the test result in the subsamples. These results are reported in Table 3.

In the second analysis, data for the preintervention (2013 and 2014) and postintervention (2016 and 2017) periods are combined to obtain the full sample of 128 observations. In addition to M1 and M2, M3 (see above) was also estimated to study the overall impact of the postintervention period on LOS. The impact of this period is captured by the year dummy variable (YRD). The results are tabulated in Table 4. All regressions are estimated using an ordinary least squares (OLS) method.

3.4 | Statistical findings LOS

Results for the aggregate sample in Table 3 shows that M1 coefficients for the specialist Parkinson's nurse (PDN) are statistically significant at the 5% level. Thus, this result supports the view that the number of services performed by the Parkinson's nurse predicts reduced hospital LOS. More specifically, the coefficient for PDN has a negative sign, providing evidence that the intervention by the specialist Parkinson's nurse reduces LOS by 0.37 day, which is economically important. For every Parkinson's patient admitted, this translates to a reduction of \$1924 (0.37 × \$5200) per day using the estimates from the IHPA. For M2, the coefficient is −0.402, which is marginally higher than M1. In Table 4, the full sample analysis shows a larger PDN coefficient, which ranges from −0.413 to −0.598.

For the 2017 subsample, the effect of the specialist Parkinson's nurse services on LOS is even greater than the aggregate sample, evidenced by the PDN coefficients of −0.741 and −0.755 for M1 and M2, respectively, which are statistically significant at the 1% level. In contrast, the results are not statistically significant in the 2016 subsample. Thus, it would appear that the findings are sensitive to the selected sample period, possibly driven by the more frequent specialist Parkinson's nurse visits, particularly in the 2017 sample period. Nonetheless, the coefficient on PDN is statistically significant in the postintervention period as indicated in the aggregate sample.

Results for M3 as presented in Table 4 shows that the coefficient for YRD has a negative sign and is statistically significant at the 5% level. This would indicate that in the specialist Parkinson's nurse intervention period, the LOS is substantially lower than LOS for the nonintervention period by about 3 days. This result tends to support the overall findings that services provided by the specialist Parkinson's nurse reduces the LOS in the 2016–2017 sample period.

TABLE 3 Results for the regression models (2016–2017)—dependent variable: LOS

	Aggregate sample (2016–2017)		2017		2016	
	M1	M2	M1	M2	M1	M2
Intercept	5.887***	4.931***	4.971***	4.491**	7.201***	6.105***
	[0.930]	[1.074]	[1.560]	[1.658]	[0.932]	[1.124]
PDN	−0.370**	−0.402**	−0.741***	−0.755***	0.214	0.159
	[0.176]	[0.175]	[0.244]	[0.245]	[0.199]	[0.196]
OPN	0.186***	0.187***	0.211***	0.209***	0.015	0.006
	[0.016]	[0.016]	[0.019]	[0.019]	[0.048]	[0.047]
RAD		2.329*		1.807		2.431
		[1.368]		[2.053]		[1.477]
N	64	64	32	32	32	32
R^2	.695	.709	.822	.827	.047	.131

Note: Standard errors are in parenthesis.
**p* < .1.; ***p* < .05.; ****p* < .01.

In terms of goodness-of-fit of the regression models, models estimated from the 2017 subsample have the highest R^2 of .822 (M1) and .827 (M2) while the 2016 subsample has the lowest goodness-of-fit of less than .14. Thus, the estimated regression models fit the observed data substantially better in the 2017 subsample, explaining more than 80% of the variation in LOS. In other words, more reliable estimation can be obtained from the 2017 subsample. On the whole, the benefit resulting from the Parkinson's nurse intervention was statistically supported, evidenced by the reduction in hospital LOS, a direct result from the nurse-led clinical practice improvement project conducted in a hospital (Carroll et al., 2020).

TABLE 4 Results for the Regression models (full sample)—dependent variable: LOS

	Full sample (2013–2017)		
	M1	M2	M3
Intercept	7.372***	5.895***	7.355***
	[0.773]	[0.979]	[1.149]
PDN	−0.598***	−0.595***	−0.413*
	[0.203]	[0.199]	[0.210]
OPN	0.202***	0.201***	0.208***
	[0.018]	[0.018]	[0.017]
RAD		2.829**	2.236*
		[1.186]	[1.193]
YRD			−3.029**
			[1.306]
N	128	128	128
R^2	.51	.532	.552

Note: Standard errors are in parenthesis.
**p* < .1.; ***p* < .05.; ****p* < .01.

3.5 | Findings from cost–benefit analysis

To facilitate decision making concerning the impact of the specialist Parkinson's nurse intervention, a comparison of benefits and costs is necessary to evaluate resource implications. If the role of the specialist Parkinson's nurse is worth subsidizing, the benefits must outweigh the associated employment costs.

All acute admitted patient episodes following the 'classification and counting' for the patient episodes are costed via a diagnostic-related grouping wherein a National Weighted Activity Unit (NWAU) is applied. A NWAU is the unit of measure for pricing health care activity used in the Activity-Based Funding system. This is a single currency applied in Australia to all Activity-Based Funding hospital activity independent of settings. Currently, 1.0 NWAU = $4713 and is termed NWAU 18. For the purpose of this research, the NWAU 18 has been applied to the 2017 Parkinson's cases.

To obtain estimates for hospital cost per patient, the average total hospital cost per patient based on NWAU pricing is collected from the Activity-Based Portal for the Mid North Coast Local Health District. In Table 5, 'Total hospital cost per patient' includes hospital costs for three Hospitals serviced by the specialist Parkinson's nurse in the Coffs Harbour region. These are denoted as 'Ex.1', 'Ex.2' and 'Ex.3'. Under the Activity-Based Funding system across the three hospitals, therefore, the total cost per patient ranges from 1.5 to 2.1 NWAU. The 'Total specialist Parkinson's nurse salary cost per patient' is estimated over the specialist Parkinson's nurse service period from 2015 to 2017 ($1110 per patient = $185,000 per year ×3 years/500 patients, an average annual salary cost of $185,000 is assumed).

Three investment evaluation criteria under the cost–benefit framework are employed: (i) benefit–cost ratio, (ii) net present value (NPV) and (iii) profitability index (PI; Brent, 2006). 'Benefit per patient' is defined as the saving in total hospital cost resulting from the specialist Parkinson's nurse intervention. For example, in the case of Ex.1, 'Benefit per patient' amounts to

TABLE 5 Cost–benefit outcomes for specialist Parkinson's disease nurse intervention

	Ex.1	Ex.2	Ex.3
Total hospital cost per patient	$9793	$8047	$7041
Total specialist Parkinson's disease nurse salary cost per patient (1)	$1110	$1110	$1110
Total hospital cost for 500 patients	$4,896,500	$4,023,500	$3,520,500
Total specialist Parkinson's disease nurse salary cost for 500 patients	$555,000	$555,000	$555,000
Total benefits for 500 patients	$4,341,500	$3,468,500	$2,965,500
Benefit per patient (2)	$8683	$6937	$5931
NPV for 500 patients over 3 years	$3,242,823	$2,479,147	$2,039,136
PI for 500 patients over 3 years	6.84	5.47	4.67
Benefit–cost ratio [(2)/(1)]	7.82	6.25	5.34

Abbreviations: NPV, net present value; PI, profitability index.

$8683 (=$9793 − $1110). 'Benefit–cost ratio' is a ratio of benefit per patient to salary cost per patient; a ratio over 1.0 indicates a net gain and is thus desirable. NPV is the difference between the present value (PV) of benefits (calculated over the specialist Parkinson's nurse intervention period) and salary costs incurred at the start of the specialist Parkinson's nurse employment period. This criterion is calculated as the PV of future benefits over 3 years (2015 to 2017), minus the total specialist Parkinson's nurse salary costs incurred at the beginning of the intervention period using an annual discount rate of 7% (Harrison, 2010). For example, in Ex.1, the PV of future benefits for 500 patients over 3 years is $3,797,823 ((=$9793 − $1110) × (500/3) × (1 − (1 + 7%)$^{-3}$)/7%). The total salary cost of $555,000 over 3 years is then deducted from this amount to arrive at the NPV of $3,242,823 (=$3,797,823 − $555,000). PI is defined as the PV of benefits over 3 years divided by total specialist Parkinson's nurse salary costs (6.84 = $3,797,823/$555,000). The same evaluation criteria are used in Ex.2 and Ex.3.

In Table 5, all three evaluation criteria show significant net gains resulting from the employment of the specialist Parkinson's nurse, (i.e., the intervention). Notably Ex.1 has the highest hospital cost of $9793, which gives rise to the largest benefit of $8683 as the salary cost per patient stays constant across all hospitals. Based on the clarification of peer grouping and relevant NWAU pricings presented on page 11, it may be deduced that, across all three Hospitals, the benefit–cost ratios are well above 1.0, ranging from 5.34 to 7.82. This suggests that the benefits are five to seven times greater than the costs. The NPV criterion shows positive values for all hospitals and thus provides further evidence of net gains. Based on the PI criterion, Ex.1 has the highest PI because it also has the largest benefit. Again, this result is in line with those reported under the benefit–cost ratio and NPV criteria. Overall, the cost–benefit approach offers further support for the statistical evidence previously reported in Tables 3 and 4.

Overall, the impact of the specialist Parkinson's nurse intervention results in a decrease in LOS ranging from 0.37 day ($1924) to 0.755 day ($3926) after controlling for services performed by other health professionals and patient readmission.

4 | DISCUSSION

In this study, we explored the cost-effectiveness of the specialist Parkinson's nurse model of care developed as a result of the nurse-led clinical practice improvement project (Bramble et al., 2019; Carroll et al., 2020). We have presented statistical findings that demonstrate a reduction in hospital LOS for patients with Parkinson's following the establishment of the specialist Parkinson's nurse position in the MNCLHD. The statistical findings demonstrate a reduction in hospital LOS after the establishment of the specialist Parkinson's nurse role, thus reducing long-term expenditure on hospital costs. Specifically, the cost–benefit analysis showed a net dollar benefit, or savings in hospital costs, of up to $8600.00 per person over a 3-year period, as a result of the specialist Parkinson's nurse intervention. In addition, the cost–benefit analysis employed across three hospital peer grouping scenarios resulted in a ratio well above 1.0, supporting the net dollar benefit associated with the employment of a specialist Parkinson's nurse. These cost–benefit ratios ranged from 5.34 to 7.82, significantly outweighing total hospital costs for Parkinson's patient care and further supporting the statistical evidence reported for hospital LOS.

The financial cost of this disabling and degenerative neurological condition to individuals, their families, caregivers and the wider society requires positive and proactive government policies that ensure equity and access to all Australians as outlined by the World Health Organisation (2014) publication, 'Health in All Policies'. In the United Kingdom, current guidelines recommend that all people with Parkinson's should have access to the services provided by specialist Parkinson's nurse (Cockram, 2017; Radder et al., 2020).

The research findings in regard to cost-effectiveness only show the acute sector benefits (i.e., reduced hospital LOS). It is important to acknowledge that there is most likely a greater cost benefit for community-delivered care as an outcome of early and timely interventions in this specialist Parkinson's nurse model where both acute and community settings, including residential care, are serviced. This model, where the specialist Parkinson's nurse is embedded in the Local Health District, ensures services are provided to the community and the acute sector care and enables early intervention and prevention of untoward events, such as infections, symptom deterioration and deterioration in mental health.

This study provides strong evidence of benefit compared with costs in the acute sector; however, lack of financial and data information flows across the community and Primary Health Network (PHN) precluded undertaking the necessary analysis to demonstrate similar conclusions for services provided outside of acute care. Given the complexity of Parkinson's, the researchers recommend a prospective study whereby occasions of service by the specialist Parkinson's nurse are captured over a period of time in the primary health/community care sector, to illustrate how these costs of care may be reduced. While each state and territory in Australia continues to develop their own service delivery strategies, in New South Wales, the focus is on sustainable nurse-led models designed to reduce the impacts of the ageing population and an increasing prevalence of chronic illness.

4.1 | Limitations

The preliminary analysis, informed by economic overviews from Deloitte Economics (2011, 2015), provided a solid basis for conducting this retrospective study with the aim to identify hospital costs only, as a result of the intervention (the specialist Parkinson's nurse). The main limitations of this research relate to the complexity of the data, financial and information streams. The limitations experienced in this research have also been identified by Deloitte Economics and other similar studies (Deloitte Access Economics, 2015; Mudiyanselage et al., 2017).

As a data linkage research project, certain limitations are inherent in the governance of data accessible to researchers, including those associated with missing data, and variations in coding. To reduce the impact of these limitations, the study design incorporated a statistical algorithm to identify the stratified sample from the total population of approximately 500 clients with Parkinson's to ensure statistical validity for the conclusions drawn from the study. Inclusion criteria required a diagnosis of Parkinson's (diagnosis determined by a geriatrician, rehabilitation and medical physician) identified in the electronic medical record and living either in the community or in an aged care facility in the MNCLHD. The development of the program logic prior to the design of the study identified the framework for the data analysis with careful attention to reducing the potential for bias arising from confounding factors and other vulnerabilities in the data set. This approach also ensured a clear definition of the data classifications entered into the information system.

Data collection for the period 2013–2014 required access to paper-based patient files and manual collection of data. This was not only time consuming; it also introduced the potential for human error in identifying and transcribing the required data. The introduction of electronic medical records facilitated access to data for the 2016–2017 period.

5 | CONCLUSION

This cost-effectiveness study has clearly shown that the employment of the specialist Parkinson's nurse in the MNCLHD has resulted in significant savings in hospital costs as a result of reduced length of hospital stay. In addition, the cost–benefit analysis employed across the three hospital scenarios resulted in cost–benefit ratios ranging from 5.34 to 7.82, significantly outweighing the total hospital cost for Parkinson's patient care. The study findings support advocacy for sustainable specialist Parkinson's nurse positions. To date, these findings in conjunction with the research reports for the other components of this PNSW- and MNCLHD-funded project have enabled the establishment of a further three positions in coastal NSW and one on the Sunshine Coast in Queensland. Likewise, the findings are informing the design of four Department of Health funded 3-year pilot projects for specialist Movement Disorder Nurse-led services across rural Australia. Future prospective economic evaluation studies in regional and rural areas are essential to demonstrate the total costs of Parkinson's to the individual, their extended support network and community and to support sustainability of specialist Parkinson's nurse positions.

Although a small-scale project, this study constitutes important research in that it begins to address the gap in the available evidence demonstrating the cost benefits of interventions for people with Parkinson's. It is expected that the results of the study will contribute to the creation of similar nurse-led models of care for people with Parkinson's and their family and/or carers across rural and regional public health services in Australia.

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CONFLICT OF INTEREST

The authors declare there are no conflicts of interest as a result of this study.

AUTHOR CONTRIBUTIONS

Marguerite Bramble led the cost-effectiveness project, develop the study designed, reviewed the data and conducted the analysis and prepared the report and the manuscript. Alfred Wong developed the framework for quantitative data analysis, conducted the quantitative data analysis and prepared the report and the manuscript. Vincent Carroll was responsible for the oversight of prestudy, collected the study data, was responsible for the model for specialist Parkinson's nurse and prepared the report and the manuscript. Debbie Schwebel was responsible for hospital systems and database expertise, advised re protocol development for analyses and prepared the report and the manuscript. Rachel Rossiter led the overall project, prepared and submitted the conference abstracts and prepared the report and the manuscript.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

Data available in article supplementary material The data that supports the findings of this study are available in the supplementary material of this article

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